Title: Impact of Integrated Fish Farming (IFF) on Resource Use Efficiency and Farmers Livelihood

SYNOPISIS OF THE THESIS

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1. INTRODUCTION

Agriculture is facing threaten from the population growth, declining in arable land per capita and water scarcity (Fedoroff *et al.*, 2010; Satterthwaite, 2010). This problem is exacerbated and progress to make world without hunger going to be interrupted by climate change (Wheeler and Braun, 2013). Sustainable agricultural innovations are needed to meet the existing and future needs for food, agriculture systems will be needed to evolve in such a way that not only intensify production from available land (enhance land productivity), but also do this in a more water-efficient way (enhance water productivity) to ensure nutrition and food security while sustaining the associated ecosystems (Fedoroff *et al.,* 2010: Giovannucci *et al.,* 2012) in an environmentally and socially accepted way. Also, over the next decades mankind will demand more food from fewer land and water resources. Essentially, we need to produce more food from fewer resources (Schneider *et al.,* 2011) without compromising the ability of future generations to meet their own needs. Sustainable farming system integrates three main goals – ecological balance, economic profitability, and social and economic equity. Integrated fish farming (IFF) remained a key player in agricultural enterprises due it sustainability and focuses on diversified agricultural production with emphasis on fish and water.

The system which is followed in the integrated fish farming will be look to enhance both land and water productivity as medium for production. The 'increasing or improving water productivity' implies improvement in the output or yield of a crop with the water that is currently in use or available (Passioura, 2006). It generates extra production means from water as well as land. It is now widely believed that achieving increases in agricultural water productivity is the key approach to mitigating water shortages and to reducing environmental problems. It will create increased production from unit volume of water. This could further generate employment opportunity and increased income for the farmers.

It's a need for the farmers to converts the threats of water abundance into greater livelihood, empowerment generation and poverty reduction opportunities. Fish being a rich source of animal protein will enhance nutritional status and human health. Integrated fish farming ensures input use efficiency, minimizes cost of production and environmental loading.

Integrated fish farming may be known as the connection or sequential involvement of two or more human activity system, of which at least one is aquaculture. Furthermore, the linkages between aquaculture and human activities involve not only agriculture (i.e. crops, livestock, irrigation dams, canals) but also include roles in sanitation (night soil, septage or other forms of human excreta re-use, sewage treatment), nutrient recovery (hydroponic-fish, breweries) and energy recovery (culture in heated effluents of power plants, dairies, etc) (Prein, 2002). In contrast, theoreticians used to differentiate Integrated Fish Farming system from mixed farming, in which production sub-systems of a farm are not mutually supportive and do not depend on each other (Csavas, 1992).. The principle of integrated fish farming involves farming of fish along with livestock and agricultural crops. This type of farming offers great efficiency in resource utilization, as waste or by-product from one system is effectively

recycled. It also enables effective utilization of available farming space for maximizing production.

In any part of the country, the type and level of integration depends on the prevalent environmental conditions, social norms, cultural values and religious factors (Ayinla, 2003). The agricultural enterprise to be combined and their level of intensity determine the type of integration. Fish culture can be extensive, semi-intensive or intensive. The semi-intensive earthen pond fish culture is the most suitable integrated aquaculture system because of the natural ecosystem that can conveniently accommodate both crop and livestock production (Ayinla, 2003). Apart from market forces, demands for agricultural products should be put into consideration before establishing any integrated farming enterprise in any area.

Integrated fish farming combines livestock production with fish farming. Animal manure is shed directly into a fish pond as fertilizer and supports the growth of photosynthetic organisms. The livestock, mainly chickens and pigs, is often fed feed containing growth promoters (Andreas *et al.,* 2002). The farming systems are relatively confined units with little exchange of water. Manure from livestock production is administered to fish ponds; the manure is directly consumed by fish, and the release of nutrients supports the growth of mainly photosynthetic organisms (Little, 1991). This integrated fish farming system produces high yields with low input, with the fish receiving limited, if any, supplementary feed. In contrast, the livestock on the integrated farms, which includes chickens and pigs, is reared intensively, and antimicrobial agents are used as growth promoters and for prophylactic and therapeutic treatment. Within integrated fish farming systems, antimicrobials, their residues, and antimicrobial-resistant bacteria may enter the fish ponds through animal manure and/or excess feeding and are potential sources of antimicrobial-resistant bacteria (Andreas *et al.,* 2002).

Integrated fish farming is the blending of various compatible agricultural enterprises into a functional or unified whole farming system for the purpose of sustainability. It is a no waste, low cost and low energy production system in which the by-products of one enterprise is recycled into another as input (Ayinla, 2003). Various types of livestock and crops have been integrated with fish farming. Integrated culture system is quite compatible with the earthen pond culture, which in Nigeria is the most popular fish farming system particularly in the rural areas. This is due to expansive natural ecosystem the earthen pond offer, which ensures fast degradation of the organic wastes. For example, livestock manure commonly used in phytoplankton bloom generation, ensures natural oxygen supply through photosynthetic activities and also serves as natural feed source. The pond dykes are suitable for vegetable production. In swampy areas where rice cultivation is practiced, the large area needed for rice serves as a potential area for both semi-intensive and extensive fish culture.

While maximizing land use, integrated farming approach reduces cost of input, diversifies protein production encourages enterprise combination to improve profitability and therefore farmers socio-economic status (Ayinla, 2003). The impact of livestock integration with fish increases productivity by manure loading from animal's wastes. (Ayinla, 2003) also reported that, efficiency in resources use is also shared by integrating fish farming with irrigation system

as well as by utilizing inland surface waters and flood plains for cage culture, fish cum vegetable/crops integrated culture system. New forms of integrated culture system that can effectively respond to resources and environmental challenges need to be developed. In this connection attention should be given to resolving the economic and environmental challenges of stock enhancement and ranching.

Integrated fish farming system is an approach of diversifying risks, self-employment, flow of income throughout the year and recycling of energy and nutrient fluxes provide sustainable resource use. Integrated fish farming can be classified into three major systems with twelve major models. The most popular models preferred in India and suitable for waterlogged situations are mainly pond-dyke integration, fish-rice-duck/ poultry-vegetable and fish-cow/pig-duck/ poultry-vegetable. In addition to economic consideration, these systems are based on multiple recycling of carbon, energy and nutrients from biomass to livestock's-poultry/ piggery / fishery etc. and minimize environmental loading with pollutants. The overall systems are most efficient for the absorption of inputs and production of goods and services. In these systems, marginal land/wet lands are generally brought into production use, where pond serves as a focal point for direct or indirect links between other components. It this system animal/ poultry wastes are used to fertilize fishpond and crop lands. The land in return produces crops, which serve as food for animals, fish and human beings. Keeping all these aspects in view, an integrated farming system developed at farmers field was evaluated for further modifications. Water productivity in the sense of its multiple uses has also been attempted. The present study is to identify the impact towards the farmers practising integrated fish farming on resource use efficiency of production in cultivating and their products.

OBJECTIVES OF THE STUDY:

1. To explore the socio-personal, socio-economic, socio-psychological, and communicational characteristics of the farmers practising Integrated fish farming.
2. To explore different types of integrated fish farming systems adopted by the farmers.
3. To assess the impact of integrated fish farming on farmer's livelihood.
4. To evaluate the integrated fish farming in terms of enhancing input use efficiency and water productivity comparison with the common farming practices.
5. To evaluate the influence of integrated fish farming on farming and level of living.
6. To delineate the factors influencing livelihood of the farmers practising integrated fish farming.
7. To undertake SWOT analyses of Integrated fish farming.

2. REVIEW OF LITERATURE:

Little *et al.,* (1999) reported that most cultured freshwater fish are produced in Asia in semi-intensive systems that depend on livestock wastes purposely used in ponds, or draining into them. Much of the vast increase in China's recent inland aquaculture production is linked to organic fertilization, provided by the equally dramatic growth of poultry and pig production. The use of livestock wastes is still needed, even when high-quality supplementary feeds are available and they are still widely used in more intensive aquaculture systems

Prein (2002) stated the importance of nutrient recycling of otherwise unused waste materials as an important element and a benefit of integration. Approaches for new entrants to explore and plan integration on their farms are presented.

Andreas Petersen *et al.*, (2003) reported that animal manure is shed directly into a fish pond as fertilizer and supports the growth of photosynthetic organisms. The livestock, mainly chickens and pigs, is often fed feed containing growth promoters. Integrated fish farming seems to favour antimicrobial-resistant bacteria in the pond environment. This could be attributed to the selective pressure of antimicrobials in the pond environment and/or to the introduction of antimicrobial resistant bacteria from animal manure

Ayinla *et al.*, (2003) reported that aquaculture has evolved through numerous phases and stages with its potential yet to be fully tapped. To affirm this potential in contributing to human development, food security and improved standard of living, the aquaculture industry requires new approaches.

Passioura (2006) stated that to increase crop yield per unit of scarce water requires both cultivars and better agronomy. It has to manage the crop or improve its genetic makeup to: capture more of the water supply for use in transpiration; exchange transpired water for CO_2 more effectively in producing biomass; and convert more of the biomass into grain or other harvestable product.

Fedoroff *et al.,* (2010) stated that Population growth, arable land and fresh water limits, and climate change have profound implications for the ability of agriculture to meet this century's demands for food, feed, fibre, and fuel while reducing the environmental impact of their production. Success depends on the acceptance and use of contemporary molecular techniques, as well as the increasing development of farming systems that use saline water and integrate nutrient flows.

Satterthwaite *et al.,* (2010) reported that the world's level of urbanization is likely to continue increasing, as long as the long-term trend in most low- and middle-income nations is for economic growth. Globally, agriculture has to meet the demand from this rapidly growing urban population, including food that is more energy-, land-, water- and greenhouse gas emission-intensive.

Schneider *et al.,* (2011) stated that mankind in the coming decades will demand more food from fewer land and water resources. It quantifies the food production impacts of four alternative development scenarios from the Millennium Ecosystem Assessment and the Special Report on Emission Scenarios.

Giovannucci *et al.,* (2012) reported that the rural world faces a profound challenge; it's already home to about three-quarters of the world's poorest people and faces the challenging condition of increasingly limited rural lands to such as water, land, and its younger people due to migration.

Wheeler and Braun, (2013) reported that climate change could potentially interrupt progress toward a world without hunger. Stability of whole food system may be at risk under climate change because of short-term variability in supply.

3. RESEARCH SETTING

The present study is planned to be conducted in the state of Manipur. Manipur had been known throughout the ages as Kangleipak or Meeteileipak as well as by more than twenty other names. Manipur is a state in north eastern India, with the city of Imphal as its capital. Its people include the Meetei, Pangal (Muslims), Bishnupriya Manipuri's, Naga and Kuki who speak different languages of branches of the Tibeto-Burman family. Manipur before being a part of India was one of the many hundreds of kingdoms of the south and Southeast Asia. The history of Manipur dates back from nearly 3000 B.C. Its first King (locally called as "Ningthou") who ruled from Kangla at Imphal in 33 AD was Meidingu Nongdaa Lairen Paakhangba. Manipur is one of the seven states of Northeast India. The state is bound by Nagaland in the north, Mizoram in the south, Assam in the west, and by the borders of the country Burma in the east as well as in the south. The state capital of Manipur is Imphal. The state lies at a latitude of 23°83'N – 25°68'N and a longitude of 93°03'E – 94°78'E. The total area covered by the state is 22,347 km². The capital lies in an oval-shaped valley of approximately 700 square miles (2,000km²) surrounded by Blue Mountains and is at an elevation of 790 meters above the sea level. The slope of the valley is from north to south. The mountain ranges prevent the cold winds from the north from reaching the valley and bar cyclonic storms originating from the Bay of Bengal.

The state has four major river basins: the Barak River Basin (Barak Valley) to the west, the Manipur River Basin in central Manipur, the Yu River Basin in the east, and a portion of the Lanye River Basin in the north. The water resources of Barak and Manipur river basins are about 1.8487 Mham. The overall water balance of the state amounts to 0.7236 Mham in the annual water budget. (By comparison, India receives 400 Mham (million hectare meters) of rain annually.)

There are sixteen districts of Manipur-

1. Bishnupur. 2. Chandel. 3. Churachanpur. 4. Imphal-East. 5. Imphal-West.

6. Senapati. 7. Tamenglong. 8. Thoubal. 9. Ukhrul. 10. Kangpokpi 11. Noney. 12. Jiribam. 13. Pherzawl. 14. Kakching. 15. Tengnoupal. 16. Kamjong.

Climate condition of the state:

The climate of Manipur is largely influenced by the topography of this hilly region. The state is drenched in rains from May until mid-October. It receives an average annual rainfall of 1,467.5 millimetres (57.78 in). Rain distribution varies from 933 millimetres (36.7 in) in

Imphal to 2,593 millimetres (102.1 in) in Tamenglong. The precipitation ranges from light drizzle to heavy downpour. The normal rainfall of Manipur enriches the soil and helps in agriculture and irrigation. The South Westerly Monsoon picks up moisture from the Bay of Bengal and heads toward Manipur, hits the eastern Himalaya ranges and produces a massive amount of rain. The climate is salubrious with approximate average annual rainfall varying from 933 millimetres (36.7 in) at Imphal to 2,593 millimetres (102.1 in) at Tamenglong. The temperature ranges from sub0 to 36 °C (32 to 97 °F).

Agrarian condition of the state:
Manipur's climate and soil conditions make it ideally suited for horticultural crops. Growing there are rare and exotic medicinal and aromatic plants. Some cash crops suited for Manipur include litchi, cashew nuts, walnuts, orange, lemon, pineapple, papaya, passion fruit, peach, pear and plum. The state is covered with over 3,000 square kilometres (1,200 sq mi) of bamboo forests, making it one of India's largest contributors to its bamboo industry.

Economy of the state:
The 2012–2013 gross state domestic product of Manipur at market prices was about ₹10,188 crore (US$1.5 billion). Its economy is primarily agriculture, forestry, cottage and trade driven. Manipur acts as India's "Gateway to the East" through Moreh and Tamu towns, the land route for trade between India and Burma and other Southeast Asian countries.

4. Research Methodology:

i. Sampling methods
ii. Variables and measurement
iii. Methods of data collection
iv. Statistical analysis

4.1. Sampling Methods:

Present study is proposed to be conducted in the State of Manipur. Four districts of the state, namely Thoubal, Bishnupur, Imphal West and Imphal East have been selected for the purpose of the study on the basis of their topographic feature of availability of water. The selection criteria were out of the sixteen districts; these four districts located in the valley region of Manipur have a record of highest practise of integrated fish farming. The investigator’s familiarity with the culture of people in districts and command in state language would help in developing rapport with the respondents. Eight Block (Two from each district) will be considering as the main study area. The selection of Blocks will be done on the basis of concentration of the farmers practising integrated fish farming. From these selected Blocks total of 24 Gram Panchayat (three from each Block) will be taken into consideration. From each Gram Panchayat 15 farmers will be select for the study. Altogether 360 numbers of farmers from 24 Gram Panchayat would form the sample for the present study.

Multi stage random sampling technique will be followed in present study. Sampling design for primary data collection is presented below:

State Name	District Name	Block Name	Gram panchayat Name	Respondent Numbers *	Total Sample Size	Selection Procedures
Manipur	D1	B_1	GP_1	15	360	District, block, and gram panchayat will be selected purposively and respondent will be selected randomly
			GP_2	15		
			GP_3	15		
		B_2	GP_4	15		
			GP_5	15		
			GP_6	15		
	D2	B_3	GP_7	15		
			GP_8	15		
			GP_9	15		
		B_4	GP_{10}	15		
			GP_{11}	15		
			GP_{12}	15		
	D3	B_5	GP_{13}	15		
			GP_{14}	15		
			GP_{15}	15		
		B_6	GP_{16}	15		
			GP_{17}	15		
			GP_{18}	15		
	D4	B7	GP_{19}	15		
			GP_{20}	15		
			GP_{21}	15		
		B8	GP_{22}	15		
			GP_{23}	15		
			GP_{24}	15		

* The respondent will include the sample of farmers adapting different IFF which will be determined based on the proper information of the different type of IFF practise at the study site.

4.2.VARIABLES AND THEIR MEASUREMENT

The socio-personal, socio-economic, socio-psychological and extension-communication variables are such type of variables, which determine the behaviour of an individual. Appropriate operationalization and measurement of the variables help the researcher to land upon the accurate conclusion. Therefore, the selected variables for studying profile of the integrated fish farming will be operationalised and measured in following manner:

Variables		Measurement
a) Socio-personal		
1	Age (X_1)	On the basis of chronological age at the time of investigation
2	Caste (X_2)	Scale developed by Pareek and Trivedi (1964)
3	Education level (X_3)	Scale developed by Pareek and Trivedi (1964)
4	Family size (X_4)	Scale developed by Pareek and Trivedi (1964)
5	Occupation (X_5)	Structured schedule will be developed
b) **Socio-economic**		
1	Size of holding (X_6)	Structured schedule will be developed
2	Cropping intensity (X_7)	Structured schedule will be developed
3	Farm mechanization (X_8)	Structured schedule will be developed
4	Annual income from farming (X_9)	Structured schedule will be developed
5	Irrigation status (X_{10})	Structured schedule will be developed
6	Total Labour (X_{11})	Structured schedule will be developed
c) Socio- psychological		
1	Independency (X_{12})	Scale developed by Supe (1969)
2	Scientific orientation (X_{13})	Scale developed by Supe (1969)
3	Risk orientation (X_{14})	Scale developed by Supe (1969)
4	Production orientation (X_{15})	Scale developed by Samata (1977)
d) **Extension-Communication**		
1	Mass media exposure (X_{16})	Scale developed by Singh (1972)
2	Contact with personal cosmopolite (X_{17})	Scale developed by Singh (1972)
3	Contact with personal localities (X_{18})	Scale developed by Singh (1972)
4	Training received (X_{19})	Scale developed by De and Rao (2000)

Production of IFF:

The variables will be studied are area and yield of different integrated components over the space (district/block) and time (past 5-10 years) as well as area and yield as perceived by the sampled IFF farmers (360) since their first cultivation to till date. It will be studies on secondary data of area under IFF in blocks/district of Manipur during past 5-10 years (depending on the availability of data). It will be also assessed based on the responses of the sampled farmers. How long the sampled farmers have been practising IFF and what has been the area of cultivation would also indicate the trend of increase/ decrease of area under IFF, yield pattern, etc. Time line and Time Trend analyses will be carried out to assess the variations. Therefore, based on both secondary and primary data the assessment of production of IFF products will be done.

Income generated from IFF:

The variables will be cost of cultivation of IFF, production, sale of the produce, gross income, and net income/profit. The information of these variables will be obtained with the help of interview schedule from sampled IFF farmers and Income would be derived and compare with published results of both IFF and non IFF cultivation farmers in Manipur as well as India.

Water Productivity from IFF:

The variables will be the products from IFF, the quantity of water use in the form of irrigation or as a medium of cultivation, gross income etc. The information of these variables will be obtained with the help of interview schedule from sampled IFF farmers and Income would be derived and compare with published results of both IFF and non IFF cultivation farmers in Manipur as well as India.

Land Productivity from IFF:

The variables will be the products from IFF, the area of space use for cultivation or rearing of poultry/animal husbandry, gross income etc. The information of these variables will be obtained with the help of interview schedule from sample IFF farmers and Income would be derived and compare with published results of both IFF and non IFF cultivation farmers in Manipur as well as India.

Sustainable Livelihood status of IFF farmers:

For assessing the livelihood status of farmers practising integrated fish farming, Department for International Development (DFID) framework (1999) will be used. It will be measured by five categories of assets or capitals: Human capital, social capital, natural capital, physical capital, financial capital on the basis of responses of farmers on the parameters under each of the above mentioned assets on a 5-point continuum (minimum and maximum value is 1 and 5 respectively) and accordingly the scheduled will be developed for the study.

SWOT analysis of IFF farmers:

For assessing the SWOT analysis of the IFF farmers, the variables will be their strengths, weaknesses, opportunities and threats while practising the cultivation. It will help in understanding their internal and external factors that are favourable and unfavourable to practise IFF in the cultivation. It can provide the information of advantage or disadvantage over others farming and also its capability to exploit the advantage or trouble from the cultivation practise.

4.3. TECHNIQUES OF DATA COLLECTION

The primary data in the present study are to be collected directly from the farmers with the help of structured schedule through personal interview methods. The secondary data will be collected from different published sources.

4.4. ANALYSIS OF DATA:

The important statistical measures that will be used to analyse the data are:

1. Descriptive statistics such as frequency, percentage, mean, standard deviation, coefficient of variation, etc
2. Relational statistics such as correlation, linear regression, multiple regressions, path analysis, factor analysis as per the objectives of the study.
3. Tests of significance like t-test, etc.

5. UTILITY OF THE STUDY:

1. Finding of the study will help to understand the dynamism of IFF production and there different types followed.
2. The study will provide valuable information on the socio-personal, socio-economics, socio-psychological, and extension communication characteristics of the farmers practising integrated fish farming.
3. The study will provide various efficacy of the water production.
4. SWOT analysis would provide the information of advantage or disadvantage over others farming and also its capability to exploit the advantage or trouble from the IFF.

6. IMPLICATION:

Analysis of the Impact of Integrated fish farming on scaling up water productivity and farmer livelihood would provide the feedback to the planners and policy makers with respect to future steps in sustainable integrated fish farming. The delineation of SWOT analysis would guide the future advocacy strategies.

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